FACTS Devices Placement Using Sensitivity Indices Analysis Method

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Abstract – *The transmission of power has been severely limited due to limited resources and environmental restriction because in recent years, power demand has increased substantially. From the security point of view Power system stability has been recognized as an important problem. To improve operating margins necessary for system stability several conventional methods used. Many of these suffer with excessive response time and considerable amount of power loss. To overcome this difficulty, a rapid development of power electronic devices such as Flexible AC Transmission System (FACTS) devices are used, their primary application is to enhance power transfer capabilities, power system stability and allow more flexible control of power flows. By installing FACTS equipment at optimal sites, the overall system benefits are sought. But the location of these FACTS devices has been big challenge. This challenge is overcome by using Sensitivity Indices analysis method. The 'MATLAB' software is used here to write a programming code for finding out the sensitivity indices. IEEE-5 bus system is used here for the study purpose.*

Key Words: FACTS; PI; sensitivity analysis; sensitivity indices; power system security

1. INTRODUCTION

The power system needs to be operationally secure, i.e. with minimal probability of blackout and equipment damage [2][3]. The power system operation is said to be normal when the power flows and the bus voltages are within acceptable limits despite changes in load or available generation. From this perspective, security is the probability of a power system's operating point remaining in a viable state of operation [4]. Fig. 1 shows the system operating state [5].

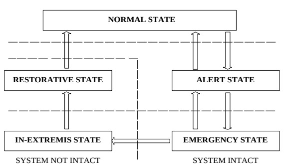

Fig-1: Power System Operating State

FACTS devices are effective and capable of increasing the power transfer capability of a line and support the power system to work with comfortable margins of stability and used to overcome the insecure problem of power system [6] [7].

In this paper, the optimal location of FACTS devices is find out using sensitivity indices analysis method. The 'MATLAB' software is used here to write a programming code for finding out the sensitivity indices. For the study purpose electrical IEEE-5 bus system is used here.

2. BENEFITS OF UTILIZING FACTS DEVICES

The advantages of utilizing FACTS devices in power system can be given as below;

- Existing transmission system can be utilize in better way with the help of FACTS devices.
- Reliability and availability of transmission system increases.
- Environmental friendly.

In many countries, increasing the energy transfer capacity and controlling the load flow of transmission lines are of vital importance. Frequently, adding new transmission lines to meet increasing electricity demand is limited by economical and environmental constraints. FACTS devices help to meet increasing electricity demand with the existing transmission systems [9].

3. PROPOSED SENSITIVITY ANALYSIS METHOD

Following sensitivity analysis method used for finding the optimal location of FACTS devices [10][11].

- Real Power Flow Performance Index Sensitivity Indices.

3.1 Real Power Flow Performance Index (PI)Sensitivity Indices

The severity of the system loading under normal and contingency cases can be described by a real power line flow performance index, as given below [13] [14];

$$PI = \sum_{m=1}^{N_L} \frac{W_m}{2n} \left(\frac{P_{Lm}}{P_{Lm}^{max}}\right)^{2n}$$

The FACTS devices should be placed on the most sensitive line. Following criteria can be used for deciding optimal placement [12].

- In real power flow performance index method, the FACTS devices should be placed in a line having most negative sensitive index.

4. SYSTEM DESRCIRPTION

Study of power system stability using sensitivity indices is done here. In this paper, idea about, which line is most sensitive in network is explain here. The analysis is done on IEEE-5 bus system. The single line diagram of the IEEE-5 bus standard test system is shown in Fig. 3, This typical system consist of three generators and five buses as shown in Fig. 3. Three generators are connected on bus 1, bus 2, bus 3 whereas the loads are connected on bus 2, bus 3, bus 4 and bus 5. The generating capacity of each generator, value of load and value of resistance and reactance are also shown in it.

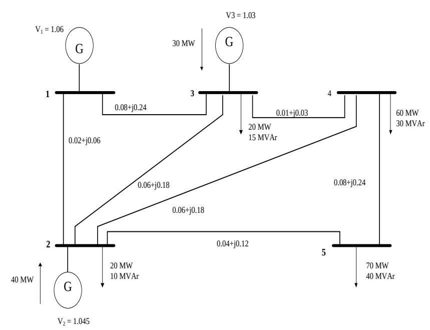

Fig-3: IEEE-5 bus system

5. RESULT AND DISCUSSION

The result obtained from the MATLAB programming are shown in TABLE I real power flow performance index sensitivity indices analysis method. Column 3rd gives sensitivity indices by using real power flow performance index sensitivity analysis method and it is denoted by b_{ij}. According to real power flow performance index method (column 3rd), line no. 1 (bij = $-4.11798e^{08}$) is most sensitive and line no. 1 is suitable for optimal placement of FACTS device. In this way to overcome the security problem of power system, optimal placement of FACTS devices can done with the help of sensitivity analysis indices method.

Table -1: Calculated Sensitivity Indices

Line	i-j	b_{ij}
1	1-2	**$-4.11798e^{08}$**
2	1-3	-29579.4
3	2-3	-26.9698
4	2-4	0
5	2-5	$1.45617e^{07}$
6	3-4	$6.99824e^{08}$
7	4-5	0

3. CONCLUSIONS

For the power system state betterment from the security point of view, optimal placing of FACTS devices is important. By introducing sensitivity analysis method, optimal place of FACTS devices is find out here. In this way by introducing Real Power flow Performance index Sensitivity Indices method, FACTS device placement is done to overcome the security problem of power system.

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BIOGRAPHIES

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